OFFSHORE WASTE MANAGEMENT – DISCHARGE, INJECT, OR HAUL TO SHORE?

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ABSTRACT

Offshore oil and gas operations generate a variety of solid and liquid wastes. Some of these wastes are attributable to exploration and production (E&P) activities (drilling wastes, produced water, treatment and workover fluids), while others are due to either human presence (sanitary wastes, food wastes) or generic industrial operations (wastepaper, scrap metal, used paints and solvents). This paper focuses on the E&P wastes, nearly all of which are disposed of in one of three ways – by discharge to the ocean, by injection into a dedicated injection well or into the annulus of a well being drilled, or by transport to a disposal site onshore. This paper updates a similar paper presented at the 5th International Petroleum Environmental Conference by incorporating several revised regulations and permits (1). It examines the current suite of U.S. regulations, permits, and policies that play important roles in shaping operators' decisions on E&P waste management and highlights the notable regional differences in permit requirements. In addition to outlining the current U.S. regulatory regime, the paper cites examples of how operators are currently managing E&P wastes.

INTRODUCTION

The United States has been a world leader in producing oil and gas from offshore platforms. The process of exploration and production (E&P) of oil generates numerous types of wastes that must be disposed of, recycled, or otherwise managed. Offshore waste management practices have evolved through U.S. requirements and international agreements. In the United States, offshore oil and gas companies have three main options for waste disposal – discharge to the sea, underground injection or encapsulation, and onshore disposal. A fourth option, incineration, has rarely been used.

The U.S. government does not dictate a specific disposal option that must be used. The U.S. legal system establishes requirements for each disposal option, and companies decide for themselves which of the options they will follow. Numerous potential waste management options exist, but many of those potential options are precluded by regulatory requirements. For example, it is technically and economically possible to dispose of oil-based drilling fluids by discharging them to the sea, but the U.S. Environmental Protection Agency (EPA) prohibits the practice (2). Therefore, that potential option is eliminated from further consideration. Many other potential options must be discarded for legal or technical reasons. Offshore operators are thus left with a reduced list of legal and technically feasible options. Operators then choose from these remaining waste management options on the basis of total costs. The total costs include capital costs, operating and maintenance costs, transportation costs, and potential future liability costs. Liability costs arise when a chosen option – legitimate at the time but later determined to be inappropriate – results in future environmental restoration costs, such as those imposed under the Superfund law, or in future health and safety costs.

TYPES OF OFFSHORE WASTES

E&P Wastes

The wastes most commonly associated with offshore E&P activities include:

- Drilling fluids,
- Drill cuttings,
- Produced water,
- Treatment, workover, and completion fluids,
- Deck drainage,
- Produced sand,
- Naturally occurring radioactive materials (NORM),
- Hydrostatic test water, and
- Other assorted wastes.

The American Petroleum Institute surveyed the U.S. onshore oil and gas industry in 1995 to estimate the volume of E&P wastes that were generated (3). Almost 18 billion barrels of produced water, about 150 million barrels of drilling waste, and about 20 million barrels of other types of E&P waste were generated from onshore oil and gas facilities in 1995. Volumes of offshore waste were not estimated in that study, but should be somewhat smaller than the volume of onshore wastes.

Human-Derived Wastes

Human-derived wastes are associated with basic human activities on offshore facilities and include:

- Sanitary wastes,
- Domestic wastes (kitchen wastes, laundry wastes, and sink and shower drainage), and
- Trash.

Other Industrial Wastes

A variety of wastes that are not specific to the offshore oil and gas industry are also generated at offshore facilities. These same wastes could be found at numerous other industrial facilities. They include, for example:

- Scrap metal,
- Wood pallets,
- Cardboard,
- Empty drums,
- Used chemicals and paint,
- Sandblasting grit and paint, and
- Cooling water.

Decommissioned Platforms

The final category of offshore waste is not a traditional waste but consists of the platforms themselves. At the end of the useful life span of the platforms, they must be removed from service and somehow disposed of.

Scope of Paper

Although all of these wastes are important, the remaining discussions in this paper are limited primarily to management and disposal of the E&P wastes, particularly drilling wastes and produced water.

REGULATORY REQUIREMENTS FOR OFFSHORE WASTES

The U.S. Legal and Regulatory System

U.S. legal requirements are developed and implemented through at least three tiers of controls. The highest tier is through laws passed by state and federal legislative bodies. Typically, laws lay out general requirements and direct agencies to develop regulations to implement regulatory programs. The regulations developed by state and federal agencies represent the second tier of legal controls. The regulations are more specific than the

laws and outline directions to regulators and standards for performance. In some regulatory areas, this is the final tier of controls. However, in many areas, the regulations are further implemented through permits that are issued to persons or organizations that are doing activities that fall under the purview of a regulatory program. The permits are issued to individual facilities or, in some cases, to groups of similar facilities in the same geographic area.

In some situations, the regulatory agencies do not go through the formal regulatory process, but instead issue guidance or policy documents. These measures also can be used to establish permit limits and controls too.

Several U.S. government agencies cooperatively regulate offshore waste management activities. The Minerals Management Service (MMS) has responsibility for overseeing oil and gas extraction activities on the Outer Continental Shelf, including activities on offshore platforms (except for discharges of wastes to the sea) and underground injection or encapsulation of offshore wastes. The EPA has responsibility for regulating discharges of offshore wastes to the sea. The MMS conducts inspections of offshore discharges for the EPA in some locations. The U.S. Coast Guard has responsibility for documenting and responding to spills of oil and hazardous materials from offshore activities, but that is not the subject of this paper. If offshore wastes are brought onshore for disposal, state agencies take over the responsibility for regulating waste management and disposal. Further, offshore discharges that occur within three miles of shore (the territorial seas) may be subject to additional, stricter state requirements. In the following sections, requirements for each type of waste disposal are discussed.

Discharges to the Sea

NPDES permits – The primary U.S. law affecting water quality and water pollution control is the Clean Water Act. The Clean Water Act requires that all discharges of pollutants to surface waters (streams, rivers, lakes, bays, and oceans) must be authorized by a permit issued under the National Pollutant Discharge Elimination System (NPDES). Individual NPDES permits can be issued to specific facilities, or general NPDES permits can be issued that cover all similar activities located in the same geographic area. For offshore oil and gas operations, EPA regional offices normally issue general permits for broad areas, such as the Eastern Gulf of Mexico (Region 4), Western Gulf of Mexico (Region 6), California (Region 9), and North Slope and Cook Inlet, Alaska (Region 10).

The heart of an NPDES permit is its numerical effluent limits. These limits describe what pollutants must be monitored and what is an acceptable quantity or concentration of the pollutants. Effluent limits are developed by considering technology-based limits developed to comply with applicable effluent limitations guidelines (ELGs), and water quality-based limits.

ELGs – ELGs are national technology-based minimum discharge requirements. These standards are developed by EPA on an industry-by-industry basis and represent the greatest pollutant reductions that are economically achievable for an industry sector or portion of the industry (e.g., offshore oil and gas platforms). Selection of ELGs involves consideration of technologies that have already been demonstrated in industrial applications, costs and economic impacts, and non-water quality environmental impacts. The ELGs are applied uniformly to every facility within the industrial sector, regardless

of where in the country the facility is located or the condition of the water body receiving the discharge. Existing facilities must meet a level of performance known as best available technology (BAT), while new facilities must meet new source performance standards (NSPS).

The EPA has developed ELGs for most major industrial categories. For the oil and gas industry, EPA developed separate ELGs for onshore activities in 1979, offshore activities in 1993, and coastal activities in 1996. Special provisions for discharges from offshore wells drilled using synthetic-based drilling fluids were added in 2000. These ELGs are compiled into the Code of Federal Regulations (2). Oil and gas activities located onshore and in coastal waters* (except for Cook Inlet, Alaska, which is treated in the same manner as offshore waters) may not discharge drilling wastes or produced water to the marine environment. In most cases, offshore oil and gas facilities are allowed to discharge these wastes to the sea. The BAT requirements for discharging drilling wastes in offshore waters are summarized in Table 1, and those for production-related wastes are shown in Table 2.

Water quality-based limits – The Clean Water Act does not prohibit discharges of materials that can be considered toxic, like metals and organic chemicals. Instead, the Clean Water Act prohibits the discharge of toxic substances in toxic quantities. This goal is accomplished through water-quality-based effluent limits that make sure ambient receiving water concentrations are low enough to maintain the designated use of the waters (for example, fishing).

ELGs serve as a foundation for the effluent limits included in a permit, but the ELGs are based on the performance of a technology and do not address the site-specific environmental effects of discharges. In certain instances, the technology-based controls may not be strict enough to ensure that the aquatic environment will be protected against toxic quantities of substances. In these cases, EPA must include additional, more stringent water quality-based effluent limits in NPDES permits. These water-quality-based limits may be numeric (EPA has published numeric water quality criteria for more than 100 pollutants that can be used to calculate water-quality-based limits) or narrative (for example, “no toxic substances in toxic quantities”). The procedures for setting these limits take into account the designated use of the water body, the variability of the pollutant in the effluent, species sensitivity (for toxicity), and, where appropriate, dilution in the receiving water (discharge conditions, water column properties).

Waste streams not covered by ELGs – Not all types of offshore wastes are covered by the ELGs, but all wastes discharged from the platform must be included in the NPDES permit. For example, wastes such as cooling water, boiler blowdown, ballast water, and others are not mentioned in the ELGs, but the general permits authorize discharge of these wastes. The permit writer calculates limits for these other types of wastes on the

*The terms onshore, coastal, and offshore can be confusing. As a simple definition, consider an imaginary line running along the coast of a country. The line crosses the mouth of rivers, bays, and inlets. Any facility to the ocean side of the line is defined as an offshore facility. Any facility to the land side of the line and located on land is classified as an onshore facility. Any facility located in or on the water or in wetlands on the land side of the line, is defined as a coastal facility. (For example, a facility located in a marsh or inside a river mouth or bay is considered to be coastal.)

basis of best professional judgment.

Other NPDES permit conditions – To a large extent, facilities are responsible for taking the steps necessary to demonstrate compliance with NPDES permit limits. Permits instruct each facility operator on the frequency for collecting wastewater samples, the location for sample collection, the pollutants to be analyzed, and the laboratory procedures to be used in conducting the analyses. Detailed records of these "self-monitoring" activities must be retained by the facility for at least three years. Furthermore, each facility is required to submit the results of these analyses to EPA on a periodic basis. For most facilities, the reporting frequency is monthly or quarterly, but in no case may it be less than once per year. Inspectors from EPA or the MMS visit the offshore platforms occasionally to monitor their discharges and make sure that all operations are in compliance with permit requirements. Failure to meet the permit limits can result in fines or loss of the permit.

NPDES permits may also include operational or environmental effects monitoring requirements. Examples of these include preparing best management practices plans (they outline good operating practices) or spill prevention plans; submitting an inventory of additives to drilling fluids; and conducting additional monitoring of the discharges, sediments, or fish tissues. The types of additional requirements that are added to NPDES general permits are summarized in Tables 3 (drilling waste requirements) and 4 (produced water requirements)

E&P wastes that cannot be discharged – Some types of E&P wastes cannot be discharged. These include oil-based drilling fluids and cuttings, produced sand, and NORM sludge and scale. The prohibition on NORM disposal does not apply to the NORM present in produced water.

Ocean Discharge Criteria Evaluation – Discharges made directly to the ocean must undergo an additional level of review to ensure that they do not cause unreasonable degradation of the marine environment. The review is based on EPA's ocean discharge criteria regulations (4). Before issuing an NPDES permit for offshore discharges, EPA must consider such factors as:

- The quantities, composition, and potential for bioaccumulation or persistence of the pollutants to be discharged;
- The potential transport of such pollutants by biological, physical, or chemical processes;
- The biological communities that may be exposed to such pollutants;
- The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery areas, and migratory pathways;
- The existence of special aquatic sites such as marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas, and coral reefs;
- The potential impacts on human health;

- Existing or potential recreational and commercial fishing; and

- Numeric water quality criteria for specific pollutants.

NPDES permits for facilities discharging into marine waters are required to include limits, including a discharge prohibition if necessary, that prevent unreasonable degradation of the marine environment. If insufficient information is available to determine whether the discharge will cause unreasonable degradation, EPA determines whether the discharge will cause irreparable harm to the marine environment and whether there are reasonable alternatives to on-site disposal. In assessing the potential for irreparable harm, EPA determines whether the facility is likely to cause permanent and significant harm to the environment on the basis of additional information collected during a monitoring period. If potential for irreparable harm is low, EPA may allow a monitoring program to demonstrate that the discharge will not cause unreasonable degradation. If data gathered through monitoring indicate that continued discharge may cause unreasonable degradation, the discharge must be halted or additional permit limitations established.

President Clinton issued Executive Order (E.O.) 13158 on May 26, 2000. Among other things, E.O. 13158 states that EPA "shall expeditiously propose new science-based regulations, as necessary, to ensure appropriate levels of protection for the marine environment." Throughout the rest of 2000, EPA held a series of public meetings and developed proposed regulations to revise the existing ocean discharge criteria regulations. On January 19, 2001, after having sent the proposed rule through an interagency review process, EPA Administrator Browner signed a proposed rulemaking to revise the ocean discharge criteria. The requirements in that proposal were significantly more stringent than those in the existing regulations. However, in accordance with the memorandum of January 20, 2001, from the Assistant to the President and Chief of Staff, entitled "Regulatory Review Plan," EPA withdrew the rulemaking document. As of October 2001, the author does not know if EPA plans to revise and repropose ocean discharge criteria regulations.

Environmental impact statements and environmental assessments - The National Environmental Policy Act requires federal agencies to consider the environmental impacts of proposed actions. When issuing a permit for new offshore oil and gas E&P facilities, EPA must develop an environmental assessment (EA) or, if impacts may be significant, an environmental impact statement (EIS). Sometimes EPA and MMS jointly prepare these documents. The EIS must consider short term and long term effects, direct and indirect effects, and beneficial and adverse environmental impacts of the proposed activity. MMS may add additional mitigation measures on discharges when the EIS or EA determines that there may significant impacts on resources of concern.

The MMS, through its Studies Program, performs research and monitoring dealing with the environmental effects of offshore oil and gas exploration, development, and production. The results of these studies are used in the EISs.

Underground Injection or Encapsulation

The Safe Drinking Water Act establishes the Underground Injection Control (UIC)

program to protect underground sources of drinking water (USDWs). Because the groundwater aquifers underlying offshore areas are not used for drinking water supply and therefore are not USDWs, offshore injection activities are not subject to the UIC program.

In U.S. offshore areas, companies may inject E&P wastes that originate on the Outer Continental Shelf into injection wells or encapsulate them in the well bore of wells that are about to be abandoned. Each application for underground waste disposal must be authorized on a case-by-case basis by the MMS. The MMS requirements for underground injection of wastes (5) are described below.

Injection wells – If companies inject wastes through underground injection wells, the formation receiving the wastes must be located below the deepest drinking water aquifer, must be isolated above and below by shale layers, and may not contain any producing wells. Companies must demonstrate that injection wells have mechanical integrity (they do not leak fluids into formations other than those that are intended to receive the fluids).

Encapsulation – Companies may use two different types of encapsulation. In the first type, wastes are placed directly in the well bore of a well that is being abandoned. In the second type, wastes are placed into a section of pipe, caps are put on both ends, and the pipe section is lowered into the well bore. In either case, the wells selected to receive the wastes must not be intersected by faults that extend upward to the sea floor and must not be located in an area with mud flows, slumps, or slides. The top of the encapsulated waste must be located at least 1,000 feet (300 meters) below the sea floor. A cement plug of at least 200 feet (60 meters) must be placed above and below the encapsulated waste.

Alaskan wells – On the North Slope of Alaska, E&P wastes are injected underground (6). In Cook Inlet, Alaska, oil-based drilling waste and sewage are injected. All current platforms in Alaska are located close to shore in locations regulated by the State of Alaska, rather than in far offshore locations regulated by the MMS. The Alaskan requirements are similar to those imposed by the MMS but they include more detailed requirements for construction and monitoring of the injection wells. Any underground disposal of NORM in Alaska must be done by encapsulation in sealed pipe sections.

Onshore Disposal

Although many types of offshore wastes can legally be discharged to the sea, companies bring some types of wastes back to shore for disposal. Some types of E&P wastes, such as oil-based drilling fluids and cuttings, produced sand, or NORM sludge and scale, are prohibited from discharge by the permits. Other wastes, such as some types of water-based drilling fluids and cuttings and some treatment, workover, and completion fluids, may not meet the permit's effluent limits and, therefore, cannot be discharged.

The U.S. law for management of most types of waste is the Resource Conservation and Recovery Act (RCRA). This law specifically exempts E&P wastes from consideration as hazardous wastes. This is a legal determination and does not necessarily reflect the chemical nature of the wastes. The RCRA places no specific requirements on E&P wastes, but leaves the authority to regulate these wastes to the individual states. Most U.S. states follow the federal hazardous waste exemption for E&P wastes. One state that receives offshore wastes, California, has regulations that require each batch of waste to

be chemically and physically tested to determine if the waste should be classified as a hazardous waste. Wastes that are hazardous are subject to much stricter and more expensive disposal requirements. Another state receiving offshore wastes, Louisiana, requires testing of most offshore wastes brought onshore.

Most E&P wastes that come onshore in the Gulf of Mexico are brought to shore bases in Texas and Louisiana. They are then transferred to onshore commercial treatment and disposal facilities in eastern Texas that either grind and inject a slurry of wastes into cap rock over a salt dome or inject the wastes into a salt cavern. Onshore disposal costs in the Gulf of Mexico region (not including transportation) were estimated in 1997 to be in the range of $8-$11/bbl (7) on the basis of interviews with commercial disposal companies. Actual costs for onshore disposal of offshore drilling wastes, on the basis of interviews with oil and gas operators in 1998, are somewhat higher. Most companies estimated that disposal costs were $10 to $50/bbl, and several companies reported disposal costs for offshore drilling wastes ranging from $100 to $418/bbl (8).

Some NORM is injected offshore, but most is brought to shore for disposal at a commercial injection well facility, where the disposal cost is approximately $150/bbl (9).

Most operators have developed comprehensive waste management plans, waste minimization programs, and recycling programs on the platforms and at the shore bases. Some differences exist in waste management practices between geographical regions because of extreme climatic conditions, lack of shore-based infrastructure, and regional air management requirements.

U.S. OFFSHORE WASTE DISPOSAL PRACTICES

Information was collected from more than 20 major U.S. offshore operators concerning their actual disposal practices in 1998 (8). Where wastes can be legally discharged to the ocean (e.g., produced water, water-based muds), most such wastes are discharged. Table 5 outlines the drilling waste disposal practices followed by 14 companies operating in the Gulf of Mexico, 6 companies operating off the California coast, 3 companies operating in Cook Inlet, and 1 company operating on the North Slope.

In the Gulf of Mexico, nearly all of the other wastes are brought to shore for disposal. Injection of E&P wastes occurs only occasionally in the Gulf of Mexico. In California, small volumes of drilling wastes and treatment, workover, and completion fluids are disposed through annular injection. Other types of wastes are brought to shore and disposed of in accordance with state rules.

In Cook Inlet, treated sewage and oil-based cuttings are injected. Other wastes are segregated at the platform and brought to shore for disposal. Trash is taken to a local landfill. Those E&P wastes that could not be discharged, including NORM wastes, are shipped to the lower 48 states for disposal. By comparison, on the North Slope of Alaska, nearly all E&P wastes are injected. Sanitary and domestic wastes are discharged. Trash is hauled to shore, where paper, metal, and styrofoam are recycled and the remainder goes to a local government waste disposal facility.

CONCLUSIONS

A variety of waste management options are available to offshore oil and gas operators in the United States. The U.S. regulatory structure is mature and is reasonably well understood by major operators. Wastes are discharged to the sea when that can be done in compliance with permits and other regulatory requirements. Those wastes that cannot be discharged are injected or are brought to shore for disposal. The industry has developed an effective infrastructure for collection, transportation, and onshore disposal of wastes that are not suitable for on-site discharge or injection.

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Table 1 – Summary of ELGs Requirements for Drilling Wastes

Baseline Requirements

- No discharge of free oil or diesel oil (using a static sheen test)
- 96-hour LC50 > 30,000 ppm (using suspended particulate phase and EPA's mysid shrimp toxicity test)
- Metals concentrations in the barite added to mud must not exceed:
  - 1 mg/kg for mercury
  - 3 mg/kg for cadmium
- No discharge of drilling wastes allowed within 3 miles of shore

Additional Requirements for Synthetic-Based Muds (SBMs)

- Whole muds may not be discharged
- Cuttings with up to 6.9% SBMs may be discharged
- Ester SBMs can have up to 9.4% SBM on cuttings
- Polynuclear aromatic hydrocarbon (PAH):
  - Ratio of PAH mass to mass of base fluid may not exceed 1×10^{-5}
- Biodegradation rate of chosen fluid shall be no slower than that for internal olefin
- Base fluids are tested using marine anaerobic closed bottle test
- Base fluid sediment toxicity shall be no more toxic than that for internal olefin base fluid
- Base fluid stocks are tested by a 10-day acute solid-phase test using amphipods (*Leptocheirus plumulosus*)
- Discharged cuttings are tested by a 4-day acute solid-phase test using amphipods (*Leptocheirus plumulosus*)
- No discharge of formation oil
- Whole muds are tested onshore by GC/MS
- Discharged cuttings are tested for crude oil contamination by fluorescence method

Table 2 – Summary of ELGs Requirements for Produced Water and Other Production Wastes

Produced Water, Treatment, Workover, and Completion Fluids

- Oil and grease limits before discharge
  - 29 mg/L monthly average
  - 42 mg/L daily maximum
- ELGs for coastal waters require zero discharge except in Cook Inlet, Alaska
  - Offshore limits are required there

Produced sand

- No discharge allowed

Table 3 – Summary of Permit Requirements for Drilling Wastes In Addition to ELGs

Other Permit Requirements for Gulf of Mexico

- No discharge of drilling wastes within 1,000 meters of (Region 4) or into (Region 6) Area of Biological Concern
- No discharge of inverse emulsion muds or cuttings
- EPA is preparing permit modification to allow discharge of SBM cuttings
- Used oils from platform may not be added to muds
- Rate of discharge may not exceed 1,000 barrels/hour
- Does not apply before installation of riser
- Must maintain inventory of all additives to muds

Other Permit Requirements for California

- Case-by-case limits for allowable discharge volume of muds and cuttings
- Ranges from 29,000 bbl/year to 240,000 bbl/year
- Used oils from platform may not be added to muds
- Must report inventory of all additives to muds
- Can meet toxicity limit by using one of eight preapproved muds and testing additives
- No discharge of SBMs or cuttings

Other Permit Requirements for Alaska

- Case-by-case limits for allowable discharge volume of muds and cuttings
- Ranges from 0 to 1,000 bbl/hour, based on depth
- Drilling wastes from no more than five wells can be discharged at one location
- Must develop a mud plan outlining types of muds and additives to be used
- Must maintain an inventory of additives actually used
- Restrictions on set backs from sensitive environments and in ice-covered areas
- Must conduct environmental monitoring program to evaluate impacts of drilling discharges
- Additional monitoring for Ba, Cd, Cr, Cu, Hg, Pb, and Zn

Table 4 – Summary of Permit Requirements for Produced Water in Addition to ELGs

Other Requirements for Region 4 (Eastern Gulf of Mexico)

- No discharge allowed within 1,000 meters of Area of Biological Concern
- Toxicity: 96-hour LC50 must not exceed concentration determined by using critical dilutions
  - Mysid shrimp (*Mysidopsis bahia*)
  - Inland silverside minnow (*Menidia beryllina*)
- Critical dilutions based on water depth, pipe diameter, and flow rate
- Dilution calculated using CORMIX 2 model
- Dilution can be increased by using a diffuser or adding seawater

Other Requirements for Region 6 (Western Gulf of Mexico; > 3 miles offshore)

- No discharge within Area of Biological Concern
- Toxicity: 7-day NOEC must not exceed concentration determined by using critical dilutions
  - Mysid shrimp (*Mysidopsis bahia*)
  - Inland silverside minnow (*Menidia beryllina*)
- Critical dilutions based on water depth, discharge depth, pipe diameter, and flow rate
- Dilution calculated using CORMIX 2 model
- Dilution can be increased by using a diffuser or adding seawater
- Frequency of testing based on volume of discharge

Other Requirements for Region 6 (Western Gulf of Mexico; 0-3 miles from shore)

- No discharge allowed:
  - to areas intermittently exposed
  - in parks or wildlife refuges
  - within 1,300 feet of oyster or sea grass bed
- Toxicity
- Similar to Region 6 (>3 miles offshore)
- Other chemical monitoring
  - benzene, lead, phenol, thallium, radium 226, radium 228
- Limits based on dilution

Other Requirements for Region 9 (California)

- Sample produced water for 26 chemicals and effluent toxicity to determine if those substances are likely to cause a water quality problem
- Determine available dilution using PLUMES model
- Dilution can be increased by using a diffuser or adding seawater
- EPA has already set limits on selected chemicals at some platforms
- Discharge volume limits are set for each platform
- Conduct study of on-line oil and grease monitors

- Toxicity Requirements
    - quarterly chronic testing with red abalone (*Haliotis rufescens*)
    - annual chronic testing with plant (giant kelp – *Macrocystis pyrifera*) and fish (topsmelt – *Atherinops affinis*)
- EPA will set separate NOEC limits for each platform based on dilution
- If limits are exceeded, must sample more frequently
- If limits are still exceeded, must undertake a toxicity reduction evaluation
- Identify sources of toxicity
- Take actions to mitigate toxicity
- Retest to confirm results
- Study of impacts of produced water discharges on fish

<u>Other Requirements for Region 10 (Alaska)</u>

- NOEC toxicity limits set for each platform
- Annual chronic testing using three species
    - Inland silverside minnow (*Menidia beryllina*)
    - Mysid shrimp (*Mysidopsis bahia*)
    - Mussel (*Mytilus sp*.) or Pacific oyster (*Crassostrea gigas*)
- If limits are exceeded, must sample more frequently
- If limits are still exceeded, must undertake a toxicity reduction evaluation
- Identify sources of toxicity
- Take actions to mitigate toxicity
- Retest to confirm results

Table 5 – Summary of Actual Drilling Waste Disposal Practices in 1998

Gulf of Mexico

WBMs and cuttings
- nearly all are discharged
- a small proportion of WBMs are recycled
- none are injected

OBMs and cuttings
- most OBMs are recycled
- 4 companies inject some cuttings/the rest are disposed onshore
- none are discharged

SBMs and cuttings
- nearly all SBMs are recycled
- most cuttings are discharged
- 1 company disposes cuttings onshore

California

WBMs and cuttings
- nearly all are discharged
- one company disposes cuttings onshore
- none are injected

OBMs and cuttings
- all OBMs and cuttings are brought onshore for disposal
- 1 company previously tried injection but it didn't work well

SBMs and cuttings
- not used in this area

Cook Inlet

WBMs and cuttings
- nearly all are discharged
- a small proportion of cuttings are disposed onshore
- none are injected

OBMs and cuttings
- 2 companies recycle OBMs/1 company injects them
- all 3 companies inject cuttings
- none are discharged

SBMs and cuttings
- not used in this area

North Slope Data – 1998

WBMs and cuttings
- all injected

OBMs and cuttings
- most OBMs are recycled
- all cuttings injected

SBMs and cuttings
- not used in this area